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Life History of Danais Archippus.

Danais archippus Smith-Abbot, 1, pl. 6. *Danaida plexippus* Scudder, Psyche, 1, p. 81.

As authors have differed much in their accounts of this species, I propose to relate here simply what I have myself observed.

In this part of West Virginia, *D. archippus* is, I have reason to believe, four-brooded, and the butterflies of the last brood, and these alone, hibernate. The survivors appear very early in the next spring, and are always faded and more or less broken. They may be seen on the blossoms of the wild plum, the last of March, and on lilacs and other flowering shrubs in April. The females deposit their eggs the last of April and early in May on the leaves of different species of Asclepias, beginning as soon as the plants are well out of the ground, and thereafter, without doubt, soon die, after the manner of their kind. I have watched carefully, later in the season, for worn and faded individuals, which could possibly have hibernated, and the latest date at which I have seen such was 2 June, when I took one that bore every appearance of considerable age. The ovaries were found to be empty of eggs. Every female from which I have obtained eggs in confinement, later than May, and all those which I have noticed as they were ovipositing in natural state, have been fresh colored, and evidently not long from chrysalis; so that I have no idea that this species differs in this respect from other butterflies. One brood of *D. archippus* succeeds another the season through, the females of each brood depositing their eggs within two or

three weeks after emerging from chrysalis, and soon after dying; and the last brood of the year hibernates, the females not to be impregnated till the next spring.

The number of moults is invariably four, and the most marked changes in appearance of the larvæ occur at the first and third moults. With the third, come in the long curved horns, and at the fourth they double in length. These horns are present in the stages preceding the third moult, but are shorter and straighter at the second moult, and mere stubs at the first. The whole round of changes from the laying of the egg to the appearance of the butterfly is rapid, and surprisingly so in hot weather. The females readily lay eggs in confinement, either upon the growing plant or plants cut and standing in water. I find recorded in my journal that 29 Aug. 1868, I found a larva of *D. archippus* on morning glory (Convolvulus), which I had quite forgotten. I suppose it was feeding on this plant, but I cannot now assert the fact. It remains to be verified.

I had concluded in previous years that this species must be many-brooded, from the larvæ which I had bred at different months, and outside observations, but in 1878 I undertook to breed in successive generations from early spring to the end of the season, and I give the result.

The first brood of larvæ came from eggs laid 2 May. They hatched on the 7th, and began to suspend on the 20th, and the butterflies to appear on the 30th of May. Whole period 28 days. But on 21 May fresh butterflies were seen about the gardens, and these must have come from eggs laid about the middle of April.

The second brood of larvæ proceeded from eggs laid 1 June. I saw the female ovipositing, caught her, and confined her in a bag over the plant, obtaining thus several eggs. She was certainly not a hibernator, being nearly perfect in wing, and I believed could have been one from the butterflies seen flying on 21 May. The eggs hatched 5 June. On the 20th, four larvæ made chrysalis, and their butterflies emerged 25 June. Whole period 25 days.

The third brood of larvæ proceeded from eggs laid 29–30

July, the female being not at all broken and very little worn, evidently not many days from chrysalis. On 1 August these began to hatch. On morning of 12th two larvæ suspended, and at 4 p. m. of the same day were in chrysalis, and the butterflies emerged 20 August. The several stages were ; egg, 2 to 3 days ; larva 11, chrysalis 8. Whole period 21 to 22 days. As the larva, from 2.5 mm. at hatching, reaches 4.6 mm. at maturity, this was rapid growth.

Another brood of larvæ, however, raised in May 1876, matured about as rapidly as those of August 1878, and the chrysalis much more so. The eggs were laid 14 May, hatched the 17th ; the first moult passed the 19th ; second moult the 21st ; two passed the third moult on the 22d ; these two passed the fourth moult on the 25th ; one of them made chrysalis the 29th, and its butterfly emerged 1 June. The whole period was but 17 days from the laying of the egg to the emerging of the butterfly ; the egg 3, larva 12, chrysalis 2. Here the chrysalis stage was immensely accelerated by the hot weather which then prevailed, the mercury ranging daily between 29° and 32° C.

The fourth brood of larvæ of 1878 proceeded from eggs laid 30 August, and the butterflies from them began to emerge 29 September. Whole period 30 days.

These four broods may fairly be taken to represent the usual sequence of generations in this region, for though the butterflies of the first, as I bred them, appeared 30 May, while the eggs of the second were laid 1 June, yet fresh butterflies were seen flying nine days before 30 May, and besides it is not likely that I saw the first that were on the wing. Individuals may have been out some days earlier. On the other hand, the interval between the butterflies of my second brood and the laying of eggs for the third was 34 days. Between the butterflies of the third and the laying of eggs for the fourth was but 5 days. But butterflies fresh from chrysalis were seen late in October, some weeks after my fourth had emerged. So that between the laying of eggs in early spring and the end of the season, there is ample time for a sequence of at least four generations of butterflies. When the female emerges from chrys-

alis, the eggs are not shaped: only fatty masses are found in the ovaries. It is just as in *Argynnis cybele*, on its first appearance in August, and in that species the eggs mature and are ready to be laid in about 15 days after the first butterflies are seen. This I have ascertained by many dissections and observations, in course of several years.

The eggs of *D. archippus* are laid singly on the leaves of its food-plant, and by preference on young plants. In the latter part of summer these spring up in abundance about my grounds, after the grass and weeds have received their annual cutting, and I can at any time be sure of finding eggs. In almost all cases they are laid on the upper side of the leaf, and sometimes there are two or three on the same leaf. But these have usually proceeded from different females, or have been laid at different periods, as may be known by the freshness of some and the maturity of others. At the same time larvæ of any stage may perhaps be feeding on the same plant. The young larva eats its egg-shell and presently attacks the fleshy surface of the leaf, eating out a narrow ring, of about 6 mm. diameter. After the first moult it is strong enough to cut the leaf through, and henceforth feeds on the edges.

There has been some diversity of statement as to the number of moults of *D. archippus*, but there are four, as I have already said. In all my experience with larvæ of butterflies, I know of only one species which has but three moults, viz., *Neonympha gemma* Hüb., and I should not assert this if I had not verified it repeatedly. *N. sosybius*, *N. areolatus* and *N. eurytris*, placed in the same genus, all have four moults. Indeed nearly all butterflies have four, but a few of them five. *P. philenor* has five, while all the other Papilios found in the northern states have but four. The hibernating Argynnids have five, as do the Phyciodes, but those which are many-brooded pass but four moults in the summer. Nearly all my rearing of larvæ is done in quarter litre[1] jelly glasses, with tin tops. In these the plant keeps fresh a long time, and I have not found that the larvæ suffer from the close confinement. The tops are lifted two or three times a day at least, and the

[1] *i. e.*, half pint.

glasses are thoroughly cleaned every morning. The advantage of glasses over boxes or any description of breeding-cages is that the larvæ can be inspected daily, and if need be hourly, and, by having a slip of paper attached to each glass, the changes can be recorded as they occur. If there be reason, any observation can be verified again and again. In case of *D. archippus* the facts were so verified in single individuals kept in separate glasses, and this was done with several broods of larvæ. So I can state positively that there are four moults, neither less nor more.

The change to chrysalis I shall describe from observations made last season, and it will be noticed that the account varies from the usual version. My attention was drawn to a paper in the Entomologist's Monthly Magazine for Aug. 1878, by Dr. J. A. Osborne, in which he declared that the process of pupation of the Nymphalidae had been erroneously described by authors, and that the safety of the chrysalis at the crisis of pupation was assured by a membrane which connected the chrysalis with the old caterpillar skin, and which was ruptured after the hooklets of the chrysalis had grappled with the silk; and not, as had been asserted, by the seizing of the old skin between the joints of the chrysalis, and the climbing up to the silk thereby. I watched the pupation of quite a number of larvæ of *Grapta interrogationis* soon after reading Dr. Osborne's paper, and found that a membrane or ligament always bound the last joint of the chrysalis to the old skin till the pupation was accomplished. In *G. interrogationis* this is white, 2.5 mm. long, flat, in shape of a long triangle, the narrow base of which is a little forked, and the forks fastened to the anterior ends of the two anal ridges on the chrysalis, which ridges or their equivalents (as in *D. archippus*, where there are two rows of black knobs) may probably be seen in any of the Nymphalidae, and also in the Papilionidae. That this ligament is the sole support of the chrysalis at the crisis of pupation, may be made evident by cutting off the caterpillar skin with scissors just below the ligament as the struggle to reach the button of silk begins, and so exposing the whole body of the chrysalis. The contortions of the chrysalis will not be in the least abated

thereby, and the instant the tail is freed from the sheath of skin, the chrysalis will be seen to rise, the last segment describing an arc of a circle of which the ligament is the radius, and the tail, now bent forward, will be brought around and over the packet of skin and will strike the silk. It has been suggested to me that this membrane or ligament may be the drawn out rectum, or the external cover of the rectum, and further observations may sustain that view. At present I know it only as a ligament binding the chrysalis to the old skin, as it appears to the eye. I have given a full account of the observations made by me on this pupation in a paper written for the Canadian Entomologist, but which has not yet been published, and therefore I repeat only so much here as will serve to make the history of *D. archippus* more complete.

The larva of *D. archippus* spins a button of white silk when preparing for its pupation, and after fastening therein the hooklets of its anal claspers, soon casts off, and hangs suspended, at first in the form of an oval, the head being brought up to the twelfth segment. A few hours later the body relaxes and the position becomes that of a figure 6. Still later it hangs straight down, the four anterior segments bent at a right angle to the body. When this position is reached it is evident that the final change is not far off. Soon a spasm of contraction will be seen, the body being lifted up to the last segment and let fall again. This is repeated more than once after short intervals, and is followed by a slight creeping movement of the body beneath the skin, advancing from the last segment forward. This movement increases in rapidity and intensity, and as the strain on the anterior segments becomes severe, the skin bursts on the dorsal line of the second, third and fourth segments, and the top of the head is also rent. The mesonotum of the chrysalis is first forced through, and the body is slowly divested by the continued creeping movement. The slit is oblique and the ventral side is at first covered by the skin three segments beyond the dorsal, the skin fitting tightly everywhere, except on the last segment, where it is loosening and gathering in a mass about the anal feet. When the dorsum is exposed at the tenth segment the ventral is covered at the eighth, and the effort for

the extrication of the tail begins, to be immediately followed by the lifting up of the body, so that the hooklets of the tail can grasp the silk. The body is bent sharply back while the tail is pointed outward and freed, the abdominal segments are stretched to their utmost and then contracted, one telescoping into the next successively, so that the skin is drawn into one joint after another. At the same time the chrysalis is seen to rise, the tail is bent back, and by a curving movement strikes the silk. The chrysalis has been described as climbing by the aid of the skin alone, as it is pinched between the segments. But on lifting the flap of skin entirely clear of the struggling segments, the same struggle continues, the chrysalis rises and the tail strikes the silk surely as before. The looker-on sees plainly a black ligament holding the chrysalis. This is 3.75 mm. long, flat, roundly excised at the broader end, the two prongs thus made being attached to the anterior black knobs on the last segment of the chrysalis, the other end to the extreme part of the caterpillar skin. I watched the pupation of only two caterpillars of *D. archippus*, — one from beginning of the process to the end. But in the other I lifted the flap of skin till the ligament was exposed. In doing this the whole thing unhooked from the silk, and as it lay in my hand, I pulled back the skin and was able to examine the ligament. I also lifted the chrysalis by the skin, and the ligament did not part. It did so afterwards only by a strenuous effort of the chrysalis, and then remained distended.

After the hooklets of the tail have caught the silk, the chrysalis whirls one way and then the other, the last segment twisting and screwing in order to fasten the hooklets more securely.

I had dropped one of the chrysalids of *G. interrogationis* into glycerine, at the crisis of pupation, and this was sent to an experienced microscopist for examination. He verified the existence of the membrane, and suggested that it is the rectum, or the external cover of it, drawn out and adhering to the anal ridges of the crysalis But if it be tubular it does not appear why it attaches at but two points only, namely, to the two knobs in *D. archippus*, and the hooked ends of the

ridges in Grapta. The knobs seem adapted to this special purpose, being fashioned something like a shirt stud, the neck being a little narrower than the top. This top is rounded, but on the anterior side a little pointed and prolonged, so that it makes an efficient hook to the ligament, the other attachment of which (to the skin) is higher up as the chrysalis hangs. Further examination, and sections made after the larva has suspended, are necessary in this matter. When the skin is off, the chrysalis hangs limp and greatly distended, in the shape of a long and narrow cone, irregularly truncated at base. Presently the segments begin to contract, those of the abdomen to an extreme degree, and to widen correspondingly; the head-case lengthens and the mesonotum swells out, — till in course of half an hour the characteristic shape of the genus is assumed.

DESCRIPTION OF THE PREPARATORY STAGES OF D. ARCHIPPUS.

Egg. — Conoidal, the height being to the breadth as 70 to 60, and as 75 to 50, in different examples; in some the sides are much more convex than in others; some a little flattened at top; the base flat; marked by about twenty-two prominent, smooth, vertical ribs, most of which extend from base to edge of summit, but a few terminate a little below summit; between the ribs are about thirty smooth, horizontal striæ, enclosing spaces in shape of parallelograms with rounded corners; the surface within these spaces finely wrinkled in the direction of the longer axis of the egg; on the summit, about the micropyle, are arranged six spaces, long, narrow, enlarged externally, each with a deepened median groove running to the central point; these are separated, and between each pair are one, sometimes two, similar spaces, but shorter and broader, each having a double groove; interior are two concentric rows of spaces like these last, each double grooved; the whole forming a sort of rosette, with all the grooves leading to the micropyle; color greenish-yellow, becoming later grayish. Duration of this stage from two to five days, according to the temperature.

Young Larva. — Length 2.5 mm.; cylindrical, very little largest anteriorly; the head a little broader than next (second)

segment; color of body white, tinted yellow at the junction of the segments; on each segment after the second a transverse row of short black hairs, and a few hairs back of this row; on the second an obovate black spot on each side of the dorsal line, with many black hairs; on the third and eleventh each, two subdorsal black prominences; head obovoid, the vertices rounded, smooth, black; before the moult a brown stripe appears on the middle of each segment, and pale stripes on the head. Duration of this stage from two to five days.

After 1st moult. — Length 4 mm.; cylindrical; banded with white, and pale yellow and black, the latter occupying the middle of each segment after the second, with white on each side, yellow being at the extreme edges; on the third a short, tapering, blunt, black process, flattened transversely, on each side of the dorsal line, and similar but shorter processes on the eleventh; head obovoid, at first black, but afterwards light stripes appear; these become distinct, and at last there is a black triangle with yellow centre on the front face; next above is a yellowish band, followed by a black one, then a pale line and after that black to the back of the head. Duration of this stage two to four days.

After 2d moult. — Length 7 mm.; same shape, and banded as before; several segments now show a black line on the dorsal area next after the anterior yellow band, the processes on the third and eleventh segments are straight, rounded, black, 2 and 1 mm. long respectively; head striped black and yellowish as at last stage, the upper stripes broader. Duration of this stage two to four days.

After 3d moult. — Length 12.5 mm.; the black bands deep colored, broader, and prolonged to base of body; on each side of this a white band edged without by a black line on dorsum, and then deep yellow to end of segment; the processes slender, tapering, black, 2.75 and 1.5 mm. respectively, but twenty-four hours later 4 and 1.75 mm.; each pair divergent, the anterior pair projected forward and recurved, the posterior projected backward, and also recurved; head nearly as before. Duration of this stage two to four days.

After 4th moult. — Length 28 mm., and at three to five days later reaching maturity.

Mature Larva. — Length 46 mm.; shape cylindrical, of nearly even thickness from the third to the twelfth segment; banded transversely with black, white and yellow, black on the middle of each segment, white on both sides of the black, and next the white, yellow, these two shades separated on the dorsum by a black line or narrow stripe; on the third and the eleventh segments, on each side the dorsal line, are two slender, tapering, flexible and divergent black processes; the anterior ones 8 mm., the others 4 mm. long; feet black, pro-legs black with a white lunate spot on each; head obovoid, slightly depressed at top, the vertices rounded, smooth, banded with black and yellow; on front face a black triangle enclosing yellow triangle, next above a band of yellow, then black, yellow, and at back of head black.

Chrysalis. — Length 28 mm., greatest breadth 15 mm.; cylindrical, stout; the head-case but little prolonged, rounded; mesonotum slightly prominent, rounded, followed by a shallow depression; abdomen very large, the segments extremely contracted; color light yellow-green, smooth and shining; a line of separated golden dots from posterior base of mesonotum to head-case; two similar dots on ventral side between the wing cases; a line of golden dots thickly set across the abdomen, ending at the wing cases, and bordered anteriorly by a black line; the tail black and slender and, at its base, on ventral side, on the last segment, two rows of rounded, shining, black knobs, three in each row, the outer pair larger than the others and more prominent, and a little pointed anteriorly; in some examples one or two of these knobs are missing, but the outer ones are always present. Duration of this stage from five to fifteen or more days, according to the temperature. In one instance, mentioned above, this period was restricted to two days. *W. H. Edwards.*

Some Synonyms of Butterflies. I received, 27 March 1878, the 14th part of Strecker's Lepidoptera, dated 1877 twice on the cover, but issued after 20 March 1878. In this are described as new four of my species and I suppose one of Scudder's. His *Melitaea imitata*, *M. larunda*, *Charis gaudaloupe*, *Pamphila similis* are, respectively, my *M. ulrica*, *M. dymas*, *Ch. australis*, *Amblyscirtes nysa*; his *Satyrus ashtaroth* is doubtless Scudder's *S. dionysius*; his *Libythea larvata* is, in my opinion, *L. carinenta*. As he will claim priority by his system of antedating, I think attention should be called to the matter. W. H. Edwards.